

embodiments, the second layer includes an adhesive layer or a layer of material used for adhesion or attachment, on the outer side.

**[0037]** Referring now to FIG. 3B, in some embodiments, a fluid path **36**, associated with each of the microneedles **32**, extends through at least part of the substrate **30**. The fluid path is configured to provide a fluid flow path for transport of fluid from a source to the microneedle (not shown) and through a hole in the biological barrier formed by the corresponding microneedle **32**. The fluid path shown represents some embodiments, however, in other embodiments, more than one fluid source may be used, and/or in some embodiments, the fluid path may vary. For example, if more than one fluid source is used, the fluid path may be configured such that one or more microneedles are fluidly connected to one or more fluid sources.

**[0038]** The microneedles apparatus shown in FIG. 2, in practice, may be incorporated alone or as an array of two or more. In one embodiment, the microneedle apparatus is used on the infusion end of an infusion set or cannula, where the reservoir end is connected to a reservoir or compartment that holds a fluid. One embodiment of this embodiment of the apparatus is where one or more microneedles apparatus are in fluid connection with the reservoir or compartment.

**[0039]** The height of the microneedles, in some embodiments, is chosen to allow penetration to only the stratum corneum (SC) and epidermis derma layers, avoiding contact with nerves. For example, in some embodiments, the maximum height *h* is preferably chosen to be no more than about 200 micrometers. However, for some applications, deeper penetration may be desired, and longer microneedles may be used.

**[0040]** Referring now to FIG. 3C, one embodiment includes a multi-fluid delivery system. The system includes a manifold having multiple separate compartments **38**, each capable of receiving a fluid and containing the fluid so as to not be contaminated by any adjacent compartment fluid. Although shown in this figures with three compartments **38**, the number of compartments may vary in the various embodiments, for example, the system may include one, two, three, four or more compartments **38**. Each compartment **38** is fluidly connected to at least one microneedle (not shown). The microneedles are connected to a substrate **37**. The fluid is transferred from the compartment **38** to the microneedles by way of a fluid line **39** and an opening **300** in the fluid line to the microneedle. The fluid line **39** may be any length desired, for example, from as short as a couple mm to a meter or more. In some embodiments, greater than one microneedle is fluidly connected to each of the compartments **38** so as to transfer larger volumes of fluid either quicker or over a greater surface area to a patient. The fluid contained in the compartments **38** may be any of the fluids described above. The compartments may be any compartment known in the art to hold a fluid or to hold the particular fluid. In some embodiments, the compartments are reservoirs such as those described in U.S. Patent Application 2007/0219480 published Sep. 20, 2007 which is herein/ hereby incorporated by reference in its entirety.

**[0041]** In some embodiments, the compartments are housed in a patch-pump such as the various ones described in U.S. Patent Application 2007/0219480. The various reservoirs (also called compartments) may each contain a different fluid, or two or more may contain redundant fluids. In some embodiments, one compartment contains insulin

while the others contain glucagon and, in some embodiments, another compartment may contain glycogen.

**[0042]** Referring now to FIG. 6, in some embodiments, the compartments or reservoirs are contained within a housing **60**, which may be a wearable patch pump or wearable housing, i.e., the housing attaches directly to a patient or the housing may be worn by a patient, i.e., in a pocket or clipped to a patient's clothing. In some embodiments, the delivery of the fluids from the compartments is controlled by a remote hand-held controller **62**. The patient **64** may therefore control the delivery of the fluids by a remote hand-held controller **62**. In some embodiments, the remote hand-held controller may be controlled by a person other than the patient. However, in some embodiments, the housing may be a bedside housing or other housing that may/may not be wearable. The user interface with the patient may be included on the housing itself and/or on a remote hand-held device.

**[0043]** Referring now to FIGS. 7A-7D, in some embodiments, the housing includes two portions, an X and a Y portion. In some embodiments, the X portion is reusable while the Y portion is disposable. The X and Y portion mate to form a pumping apparatus. The compartments, or reservoir, **70**, may be flexible, as shown. The compartment **70** fits into a space **72** of the Y portion. However, in some embodiments, as shown in FIG. 7C, the compartment **70** attaches first to the X portion and then fits into a space in the Y portion, as shown in FIG. 7D.

**[0044]** As shown in FIG. 7D, in some embodiments, the compartment **70** is fluidly connected to a fluid path **74** by a needle **76** or object penetrating a septum **78** on the compartment.

**[0045]** Although as shown in FIG. 7A-7D, the housing contains one compartment, in various other embodiments, the housing includes multiple compartments, each including a fluid path, and a means of fluidly connecting the compartment to the fluid path.

**[0046]** As shown in FIG. 7A, the fluid path includes an exit **79**. In various embodiments, the fluid path would extend past the exit **79** and eventually connect to a microneedle.

**[0047]** The fluid in the compartment may be pumped through the fluid line through different means. One pumping mechanism **71** is shown in FIGS. 7A-7D, although other mechanisms may be used.

**[0048]** Referring now to FIG. 8, a device **80** including a fluid compartment is shown. A fluid path **82** extends from the exit of the device **80** and through a microneedle **84** which has been inserted into a patient **86**. In various embodiments, the device may include more than one compartment including more than one exit, and/or more than one fluid line extending from the device, ending in a microneedle which may be inserted into a patient.

**[0049]** Typical embodiments include a reservoir or compartment for holding a supply of fluid. In the case of insulin, the reservoir may be conveniently sized to hold an insulin supply sufficient for delivery over one or more days. For example, a reservoir may hold about 1 to 2 ml of insulin. A 2 ml insulin reservoir may correspond to about 3 days supply for about 90% of potential users. In other embodiments, the reservoir can be any size or shape and can be adapted to hold any amount of insulin or other fluid. In some embodiments, the size and shape of the reservoir is related to the type of fluid the reservoir is adapted to hold. The fluid reservoir may